Iron K band Observations of Active Galactic Nuclei

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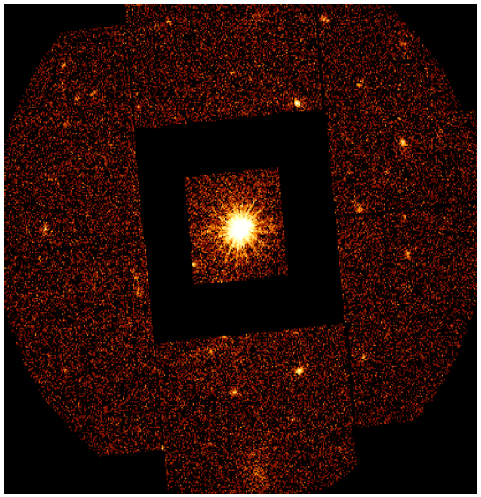
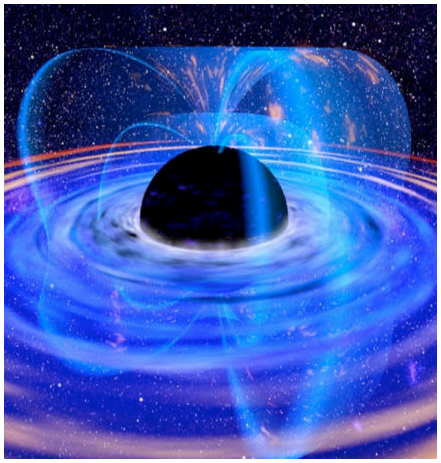
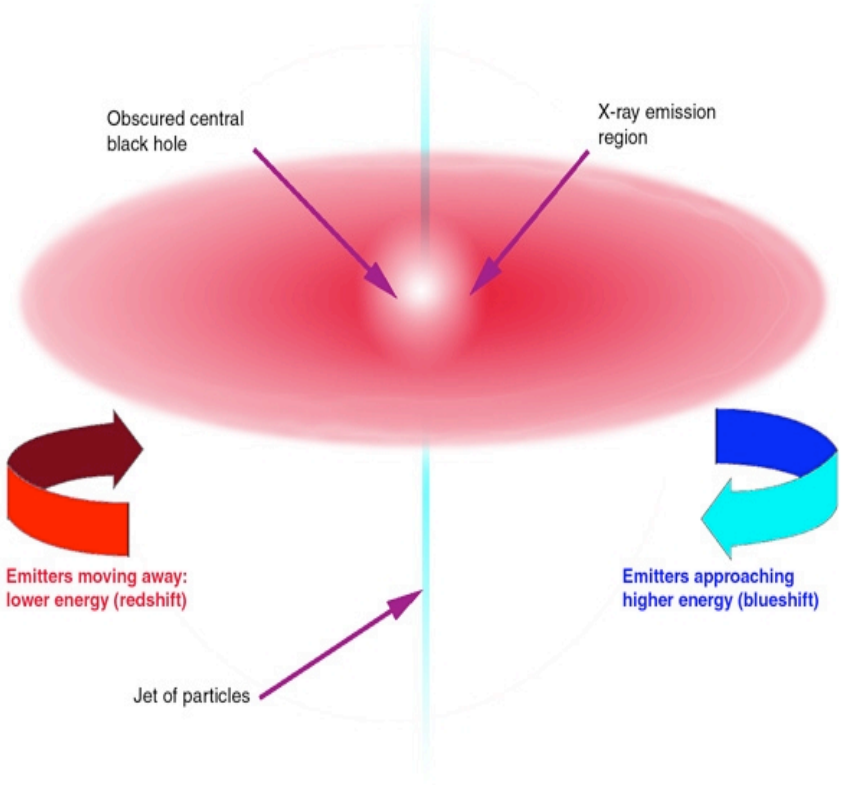
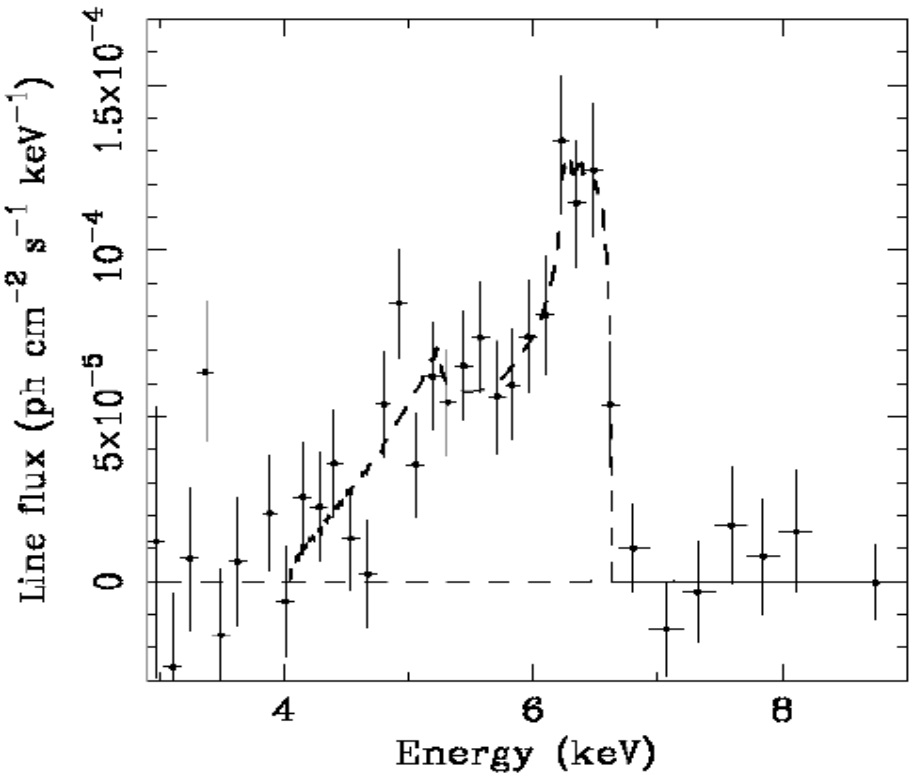




AGN accretion disc – the `broad' Fe Kα line



MCG-6-30-15: Tanaka *et al.* (1995)

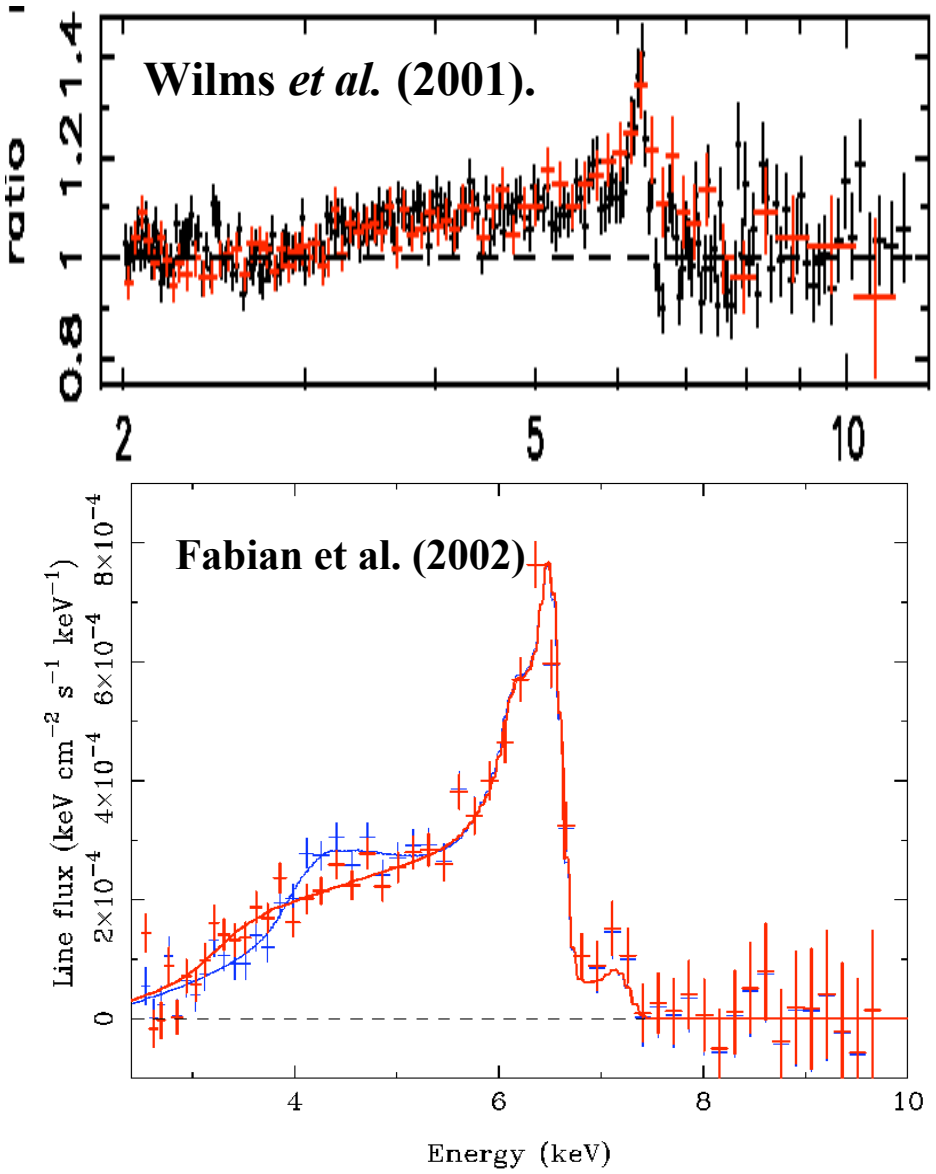


. **Hard X-rays illuminate 'cold' inner accretion disc**

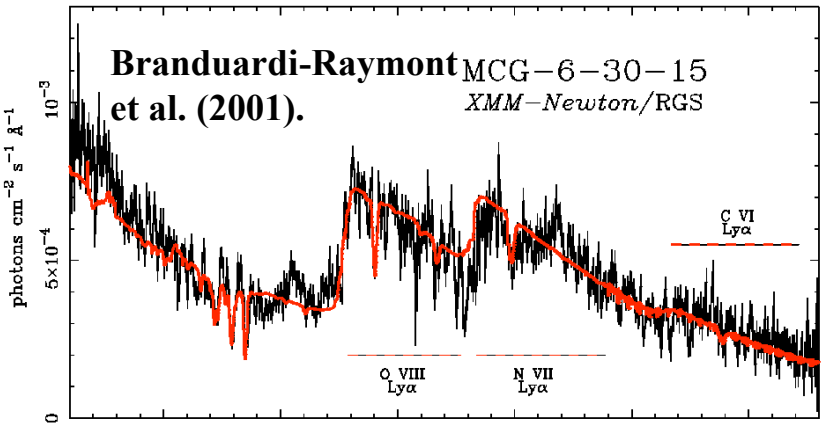
Broad Iron Kα seen by Reflection

MCG-6-30-15 – extraction of energy from a spinning black hole?

***XMM-Newton* EPIC**



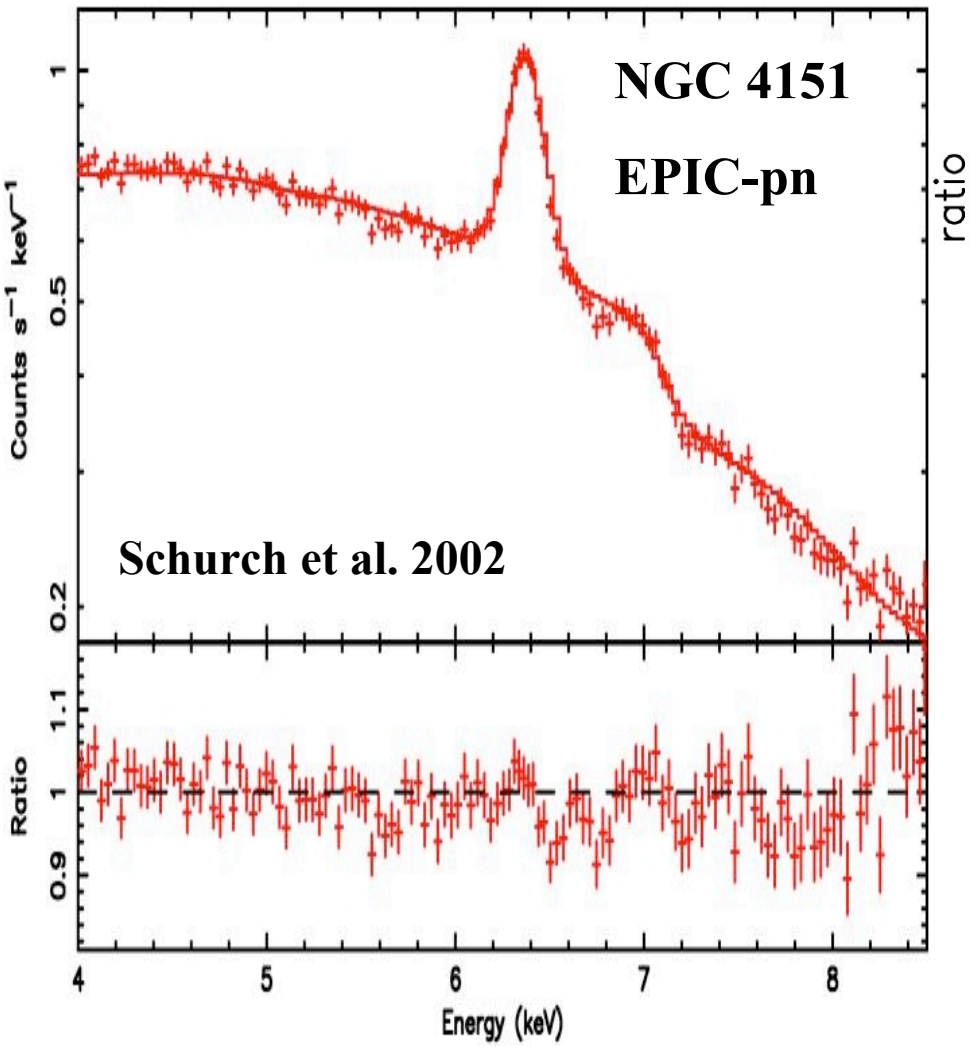
***XMM-Newton* RGS**

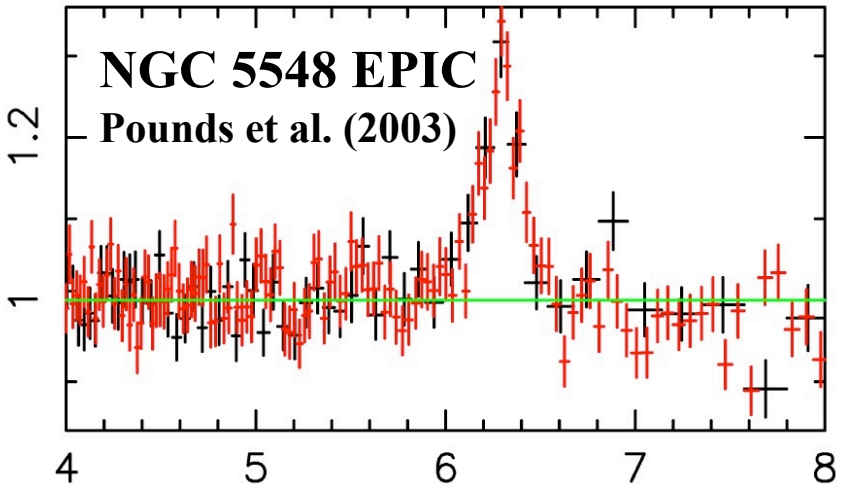


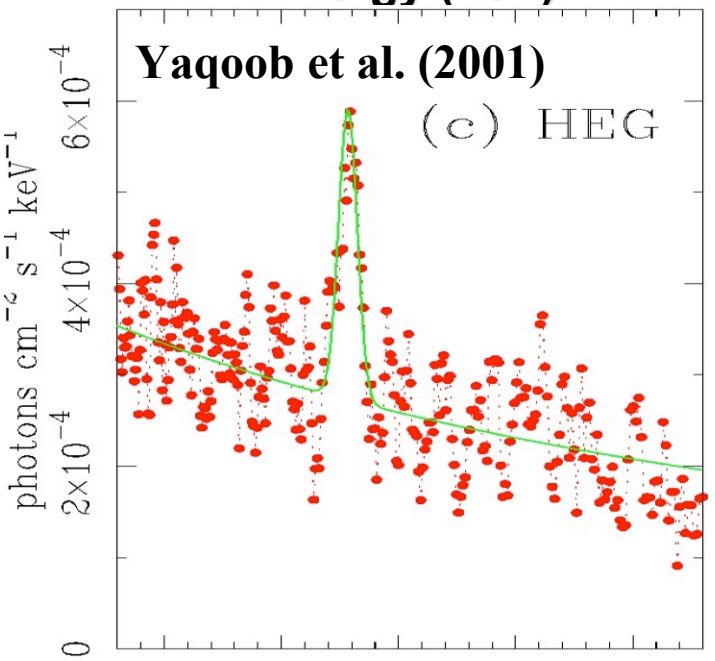
Spinning black hole?

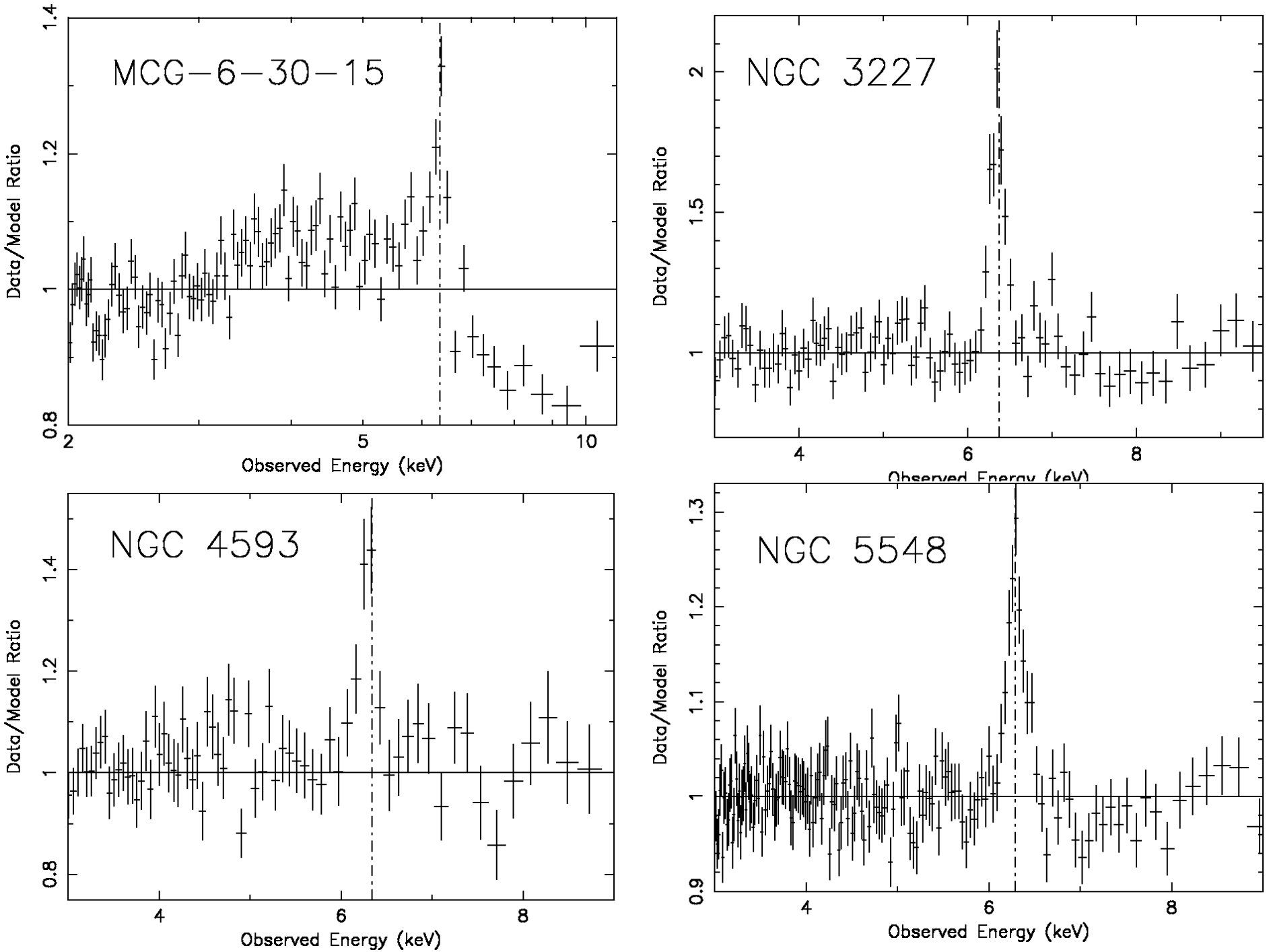
(Blandford & Znajek 1977)

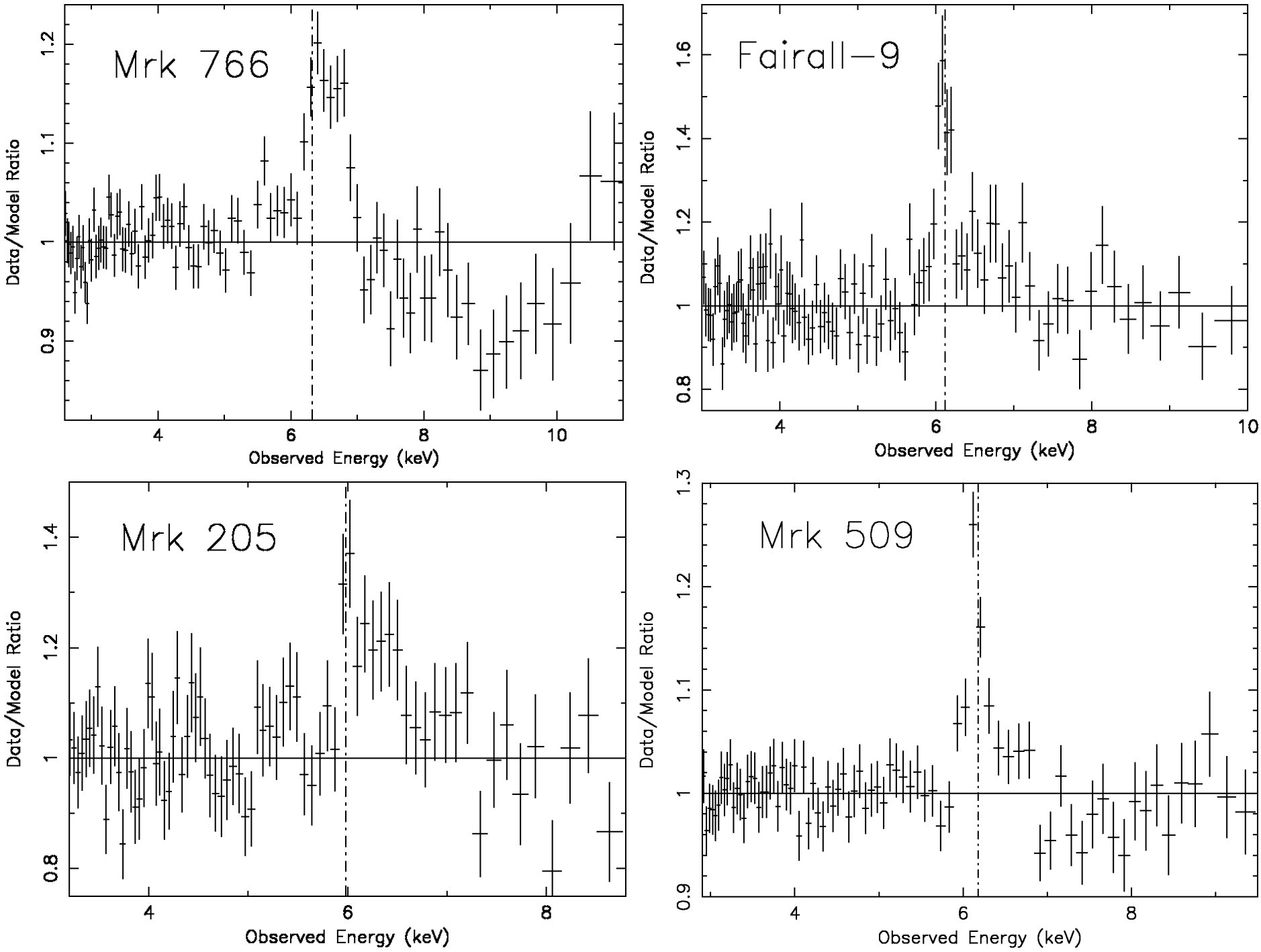
"Narrow" Iron K lines only in NGC 4151 and NGC 5548








MCG−6−30−15
NGC 3227
NGC 4593
NGC 5548
Data/Model Ratio
Observed Energy (keV)


Mrk 766
Fairall−9
Mrk 205
Mrk 509
Data/Model Ratio
Observed Energy (keV)

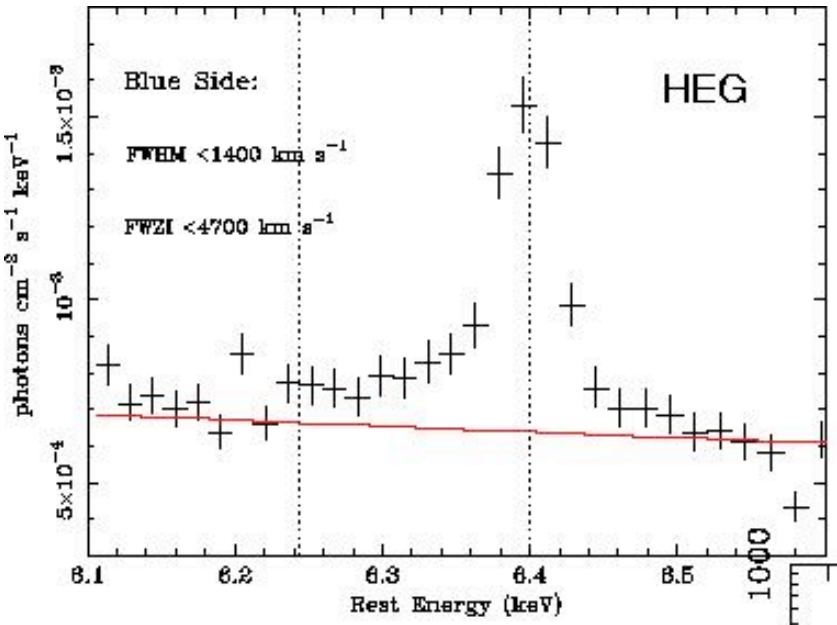
NGC 3783 – Compton Shoulder

*850 ks HEG exposure: deduce $\tau \sim 0.1$

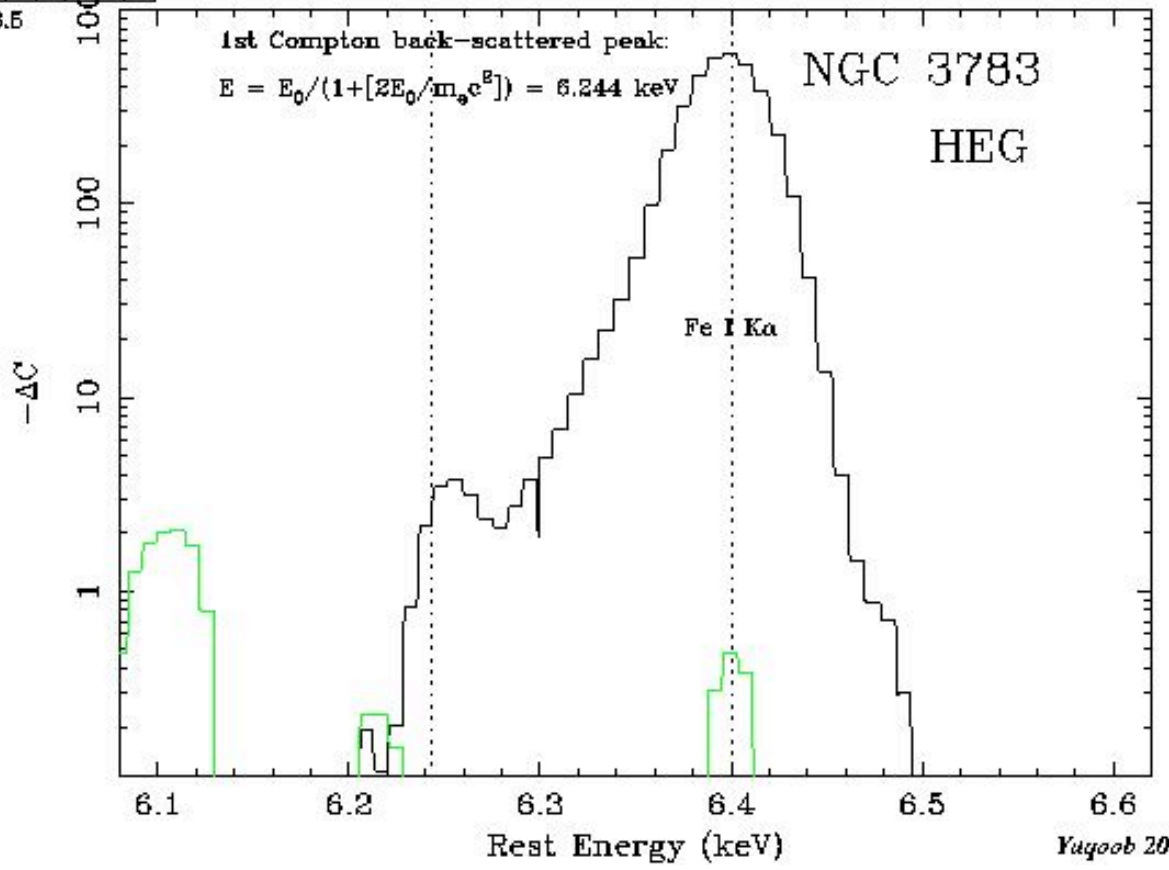
* Rules out optically–thick disk or torus.

  BLR/NLR likely.

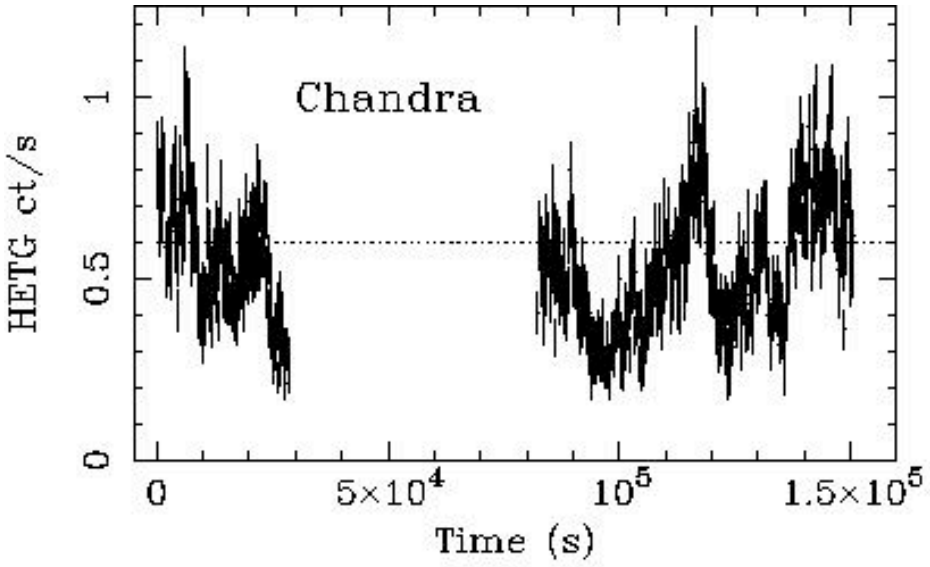
Need ~140 ks XRS to do similar science for F(2–10) = 6.1e–11 cgs



F(2–10)=6 x 10^{-11} cgs EW=70 eV



Shoulder peak close to the value for backscattering 6.400 keV photons. Deviation is a measure of kT for the medium.



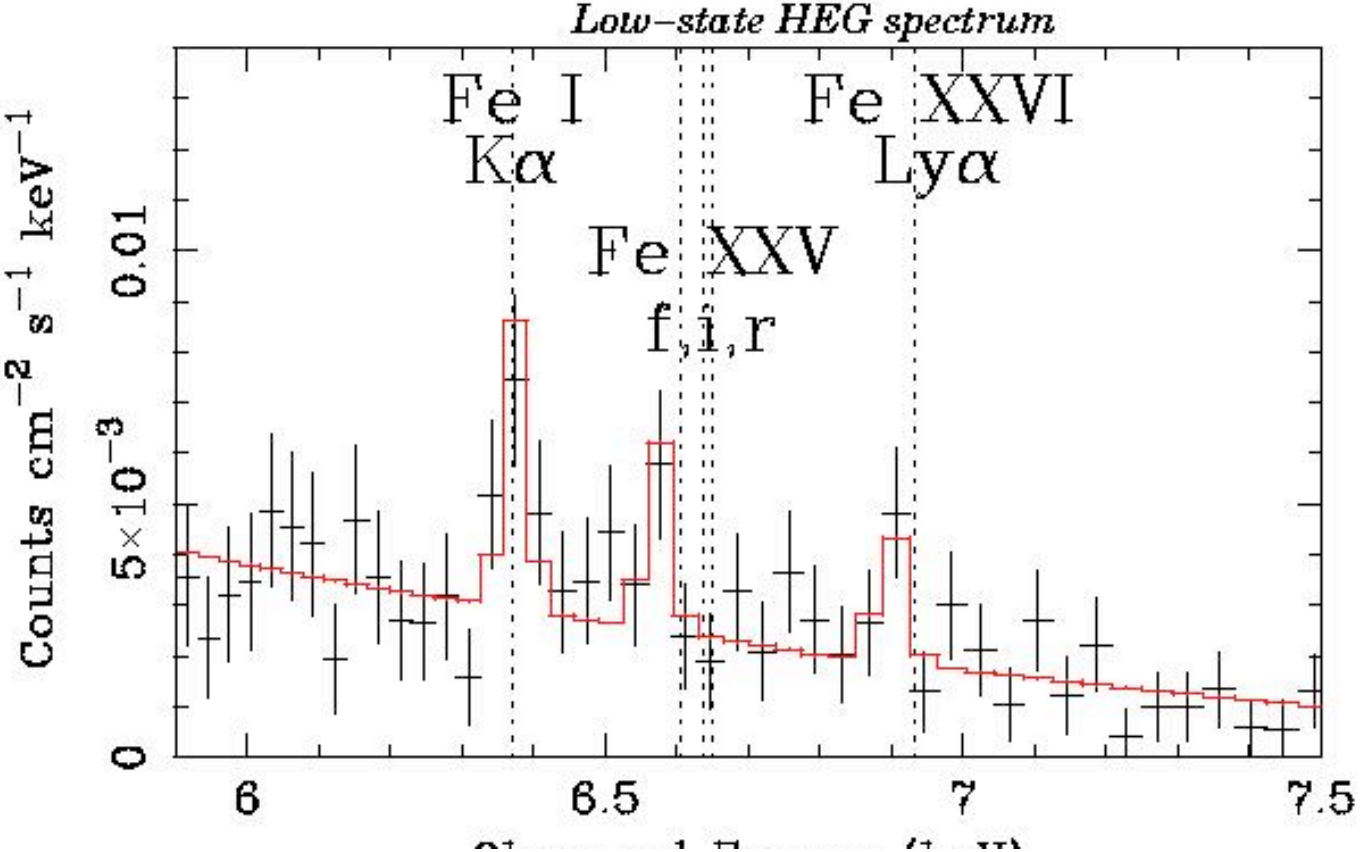
NGC 7314: Fe XXV & Fe XXVI
Narrow, rapidly variable, unresolved lines from an accretion disk.

He–like & H–like lines are redshifted, Fe I K line is not.

Redshift is ~1500 km/s, greater than systematic & statistical uncertainty.

Is He–like line f,i, or r? HEG cannot resolve.

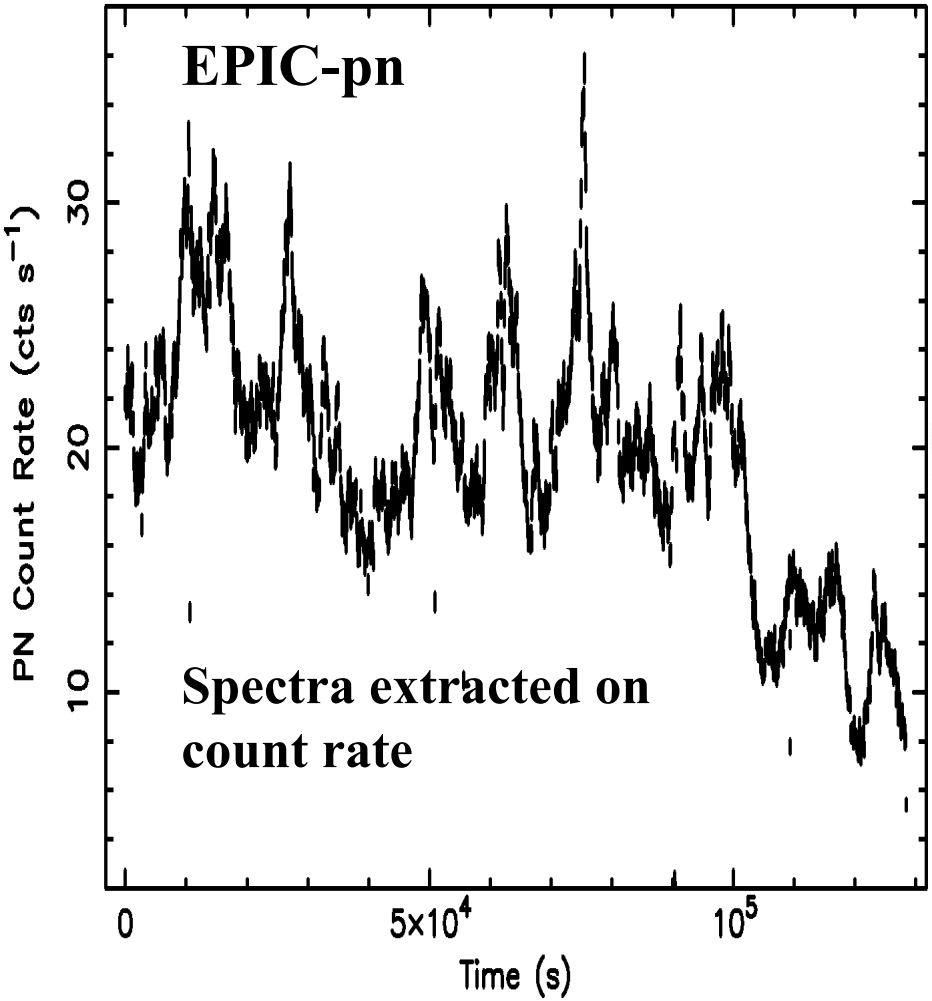
Consistent redshift with H–like line if forbidden.

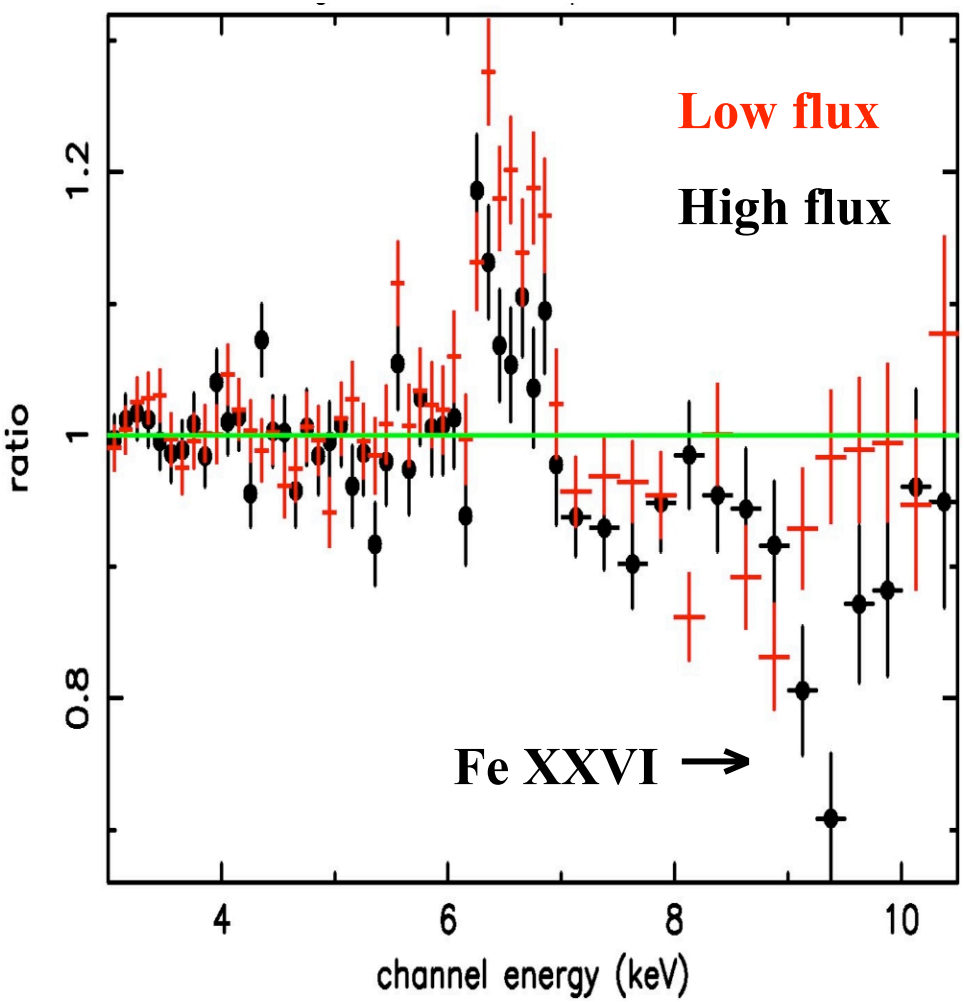


Yuqoob 2003

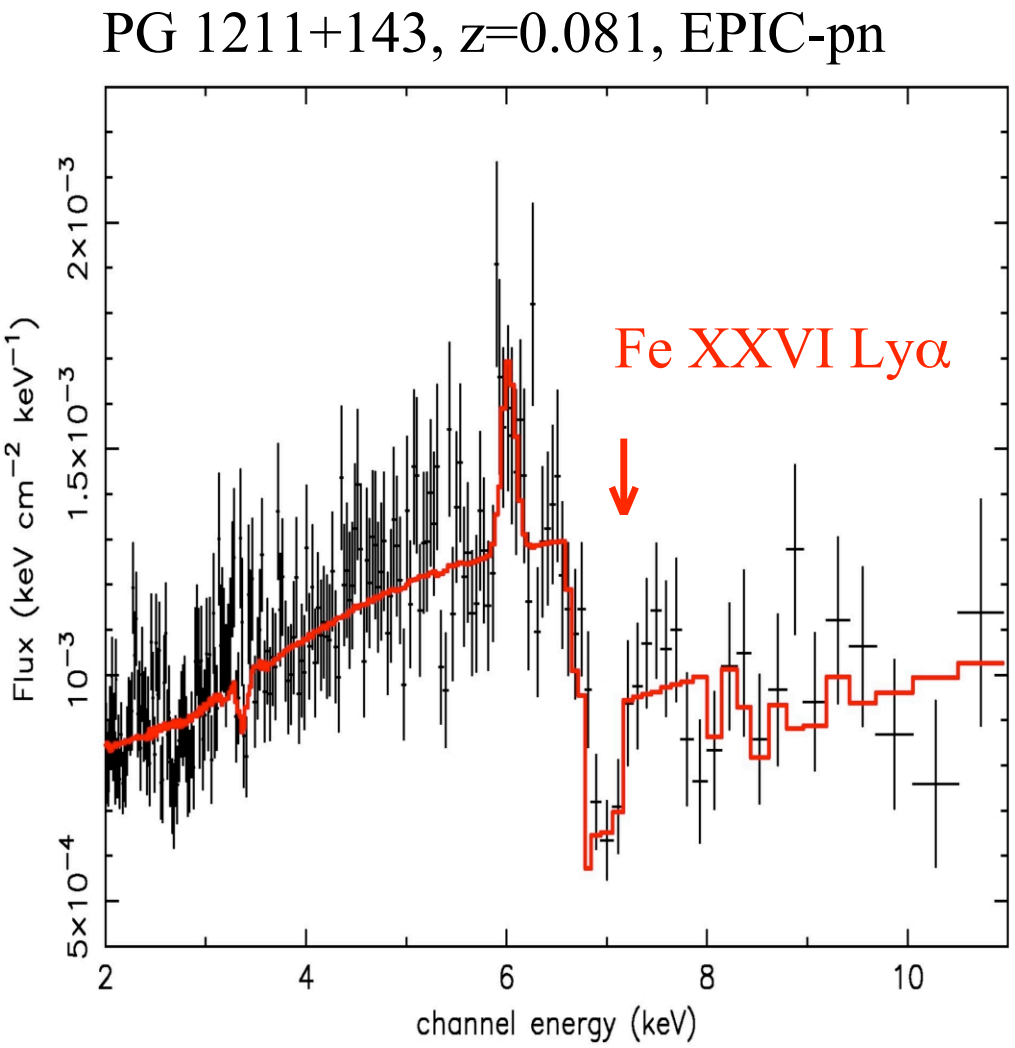
Highly Ionised Fe K Absorber in Mrk 766 - Evidence for Flare Ejecta?

Fe XXVI absorption only in high flux ("flaring") state





A Highly Ionised, Relativistic Outflow in PG 1211+143



XMM-Newton data reveal a large, highly ionised outflow

$\xi \sim 10^{3.4}$ and $N_H \sim 5x10^{23}$ cm^{-2} outflowing at ~0.1c

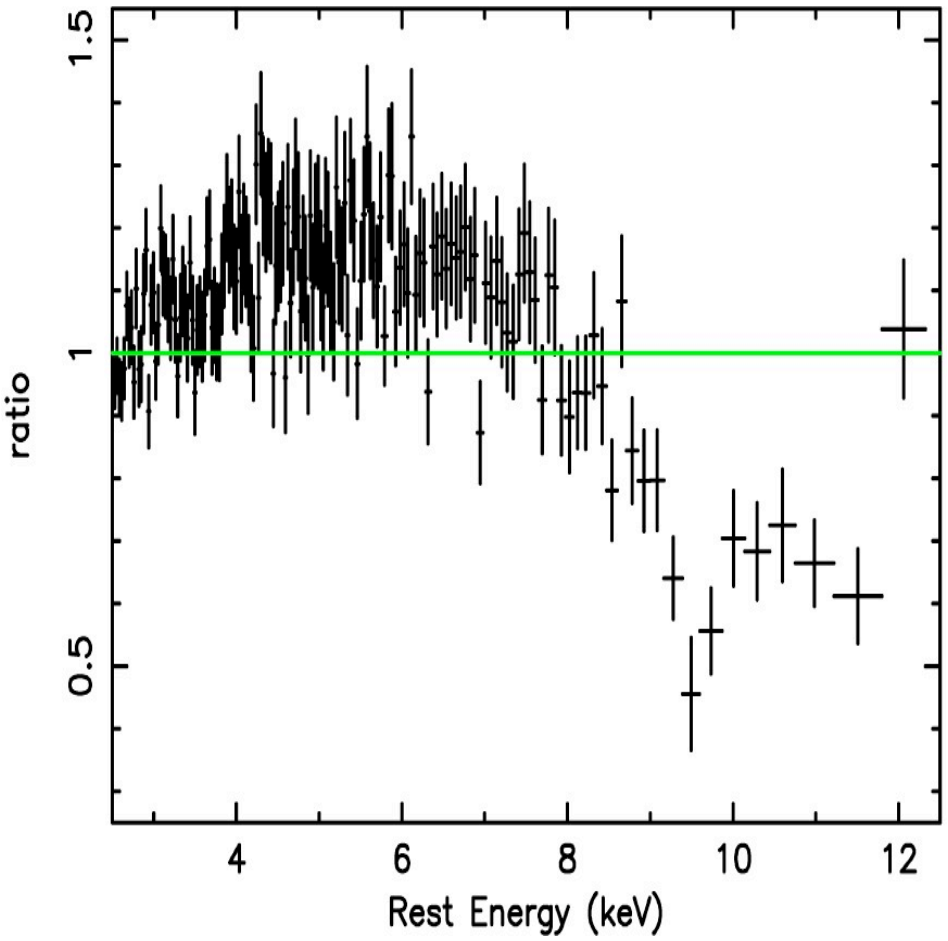
Mass-loss rate ~ 0.1 $M_\odot$ yr^{-1}

K.E. ~ 10^{43} erg s^{-1} (10% L_x)

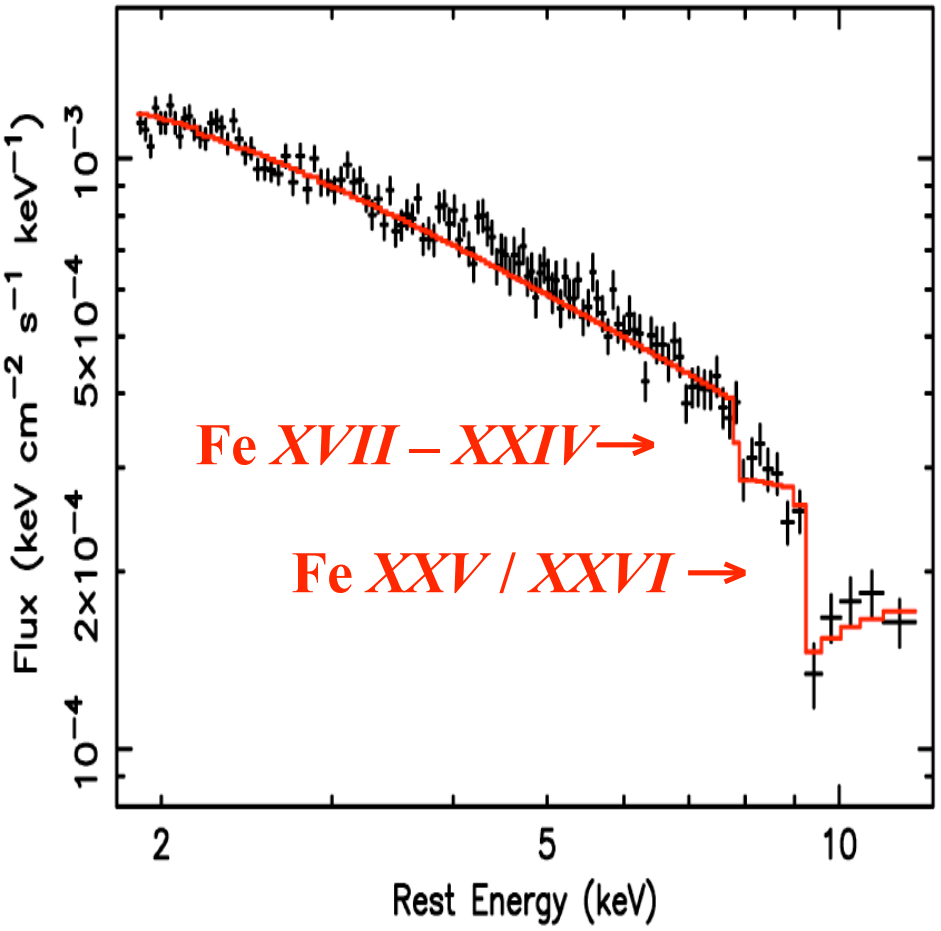
Similar flows in the BAL quasars APM08279+5255 & PG1115+080 (Chartas et al. 2003)

Iron K-shell absorption in the Quasar PDS 456

Ratio to a Power-law model

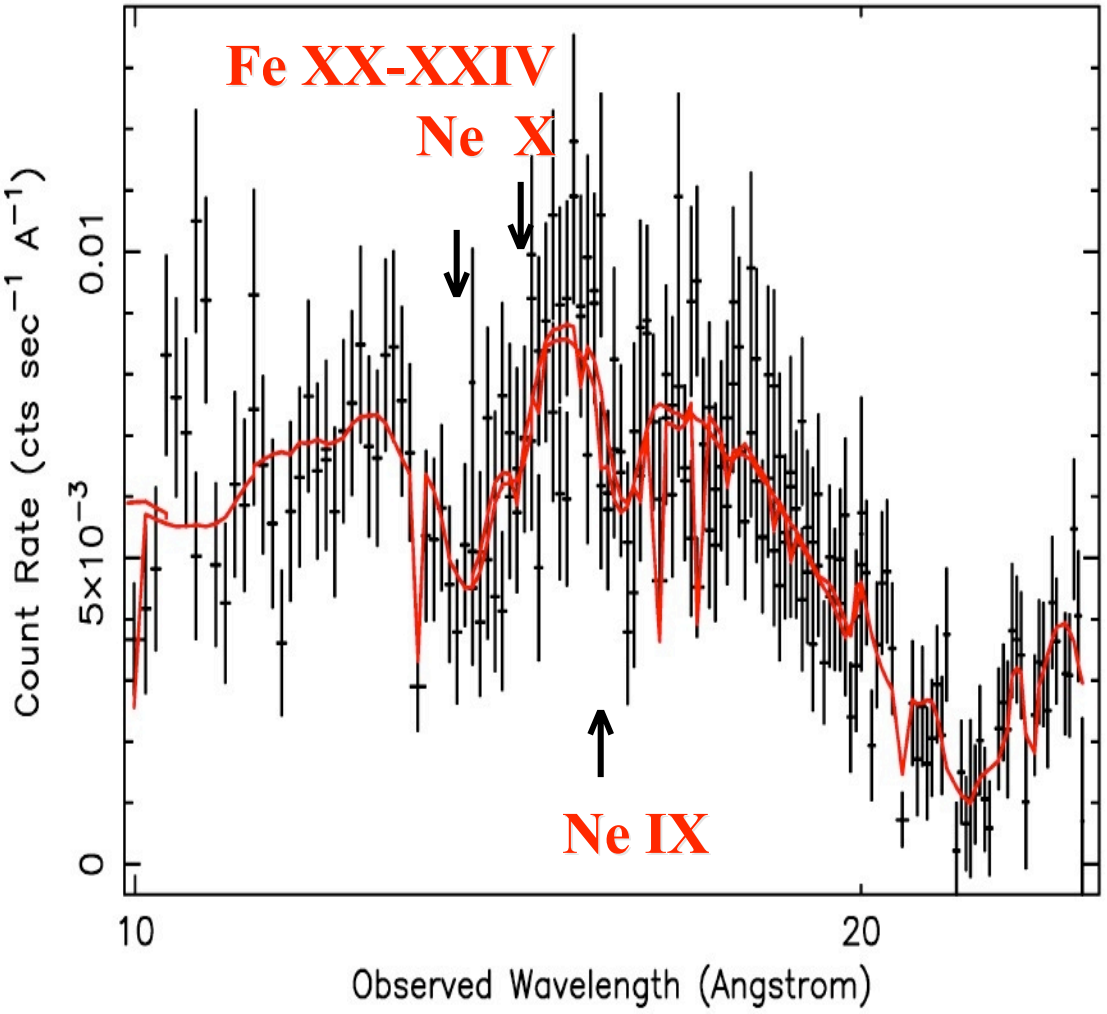


Highly Ionised Iron K edges



Broad X-ray Absorption Features in PDS 456

XMM-Newton RGS (Reeves et al. 2003)



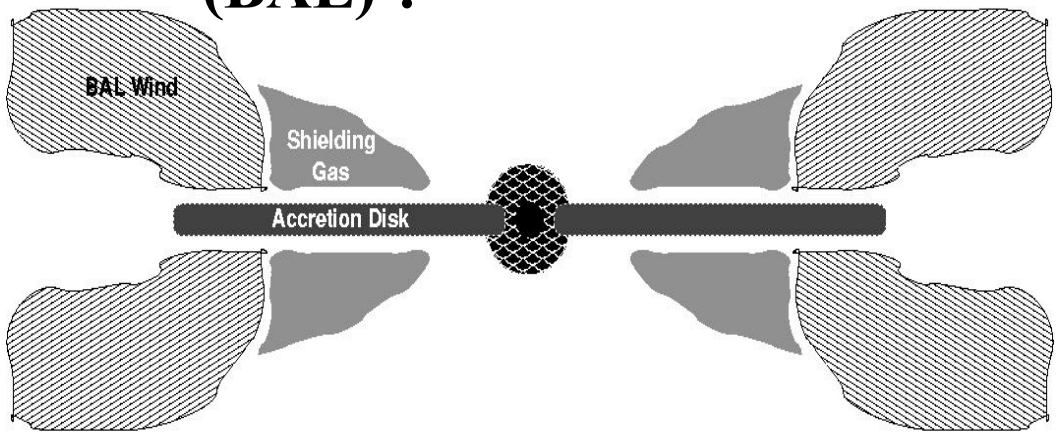
Derive $\xi \sim 10^3$ and $N_H \sim 10^{24}$ cm^{-2} outflowing at ~0.15c !

If hard X-rays driving outflow, mass-loss rate ~ 10 $M_\odot$ yr^{-1}

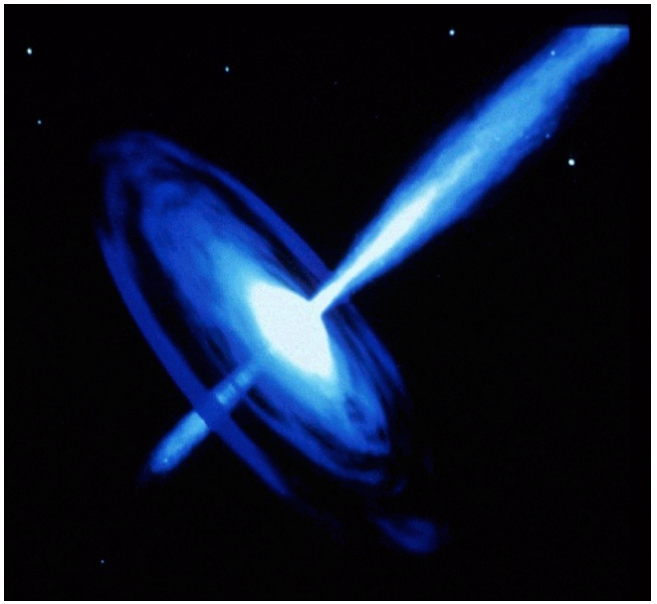
For 10% covering factor, outflow K.E. ~ 10^{46} erg s^{-1} (10% L_{bol})

Outflow geometry and driving mechanism

Flow along disk plane (BAL) ?

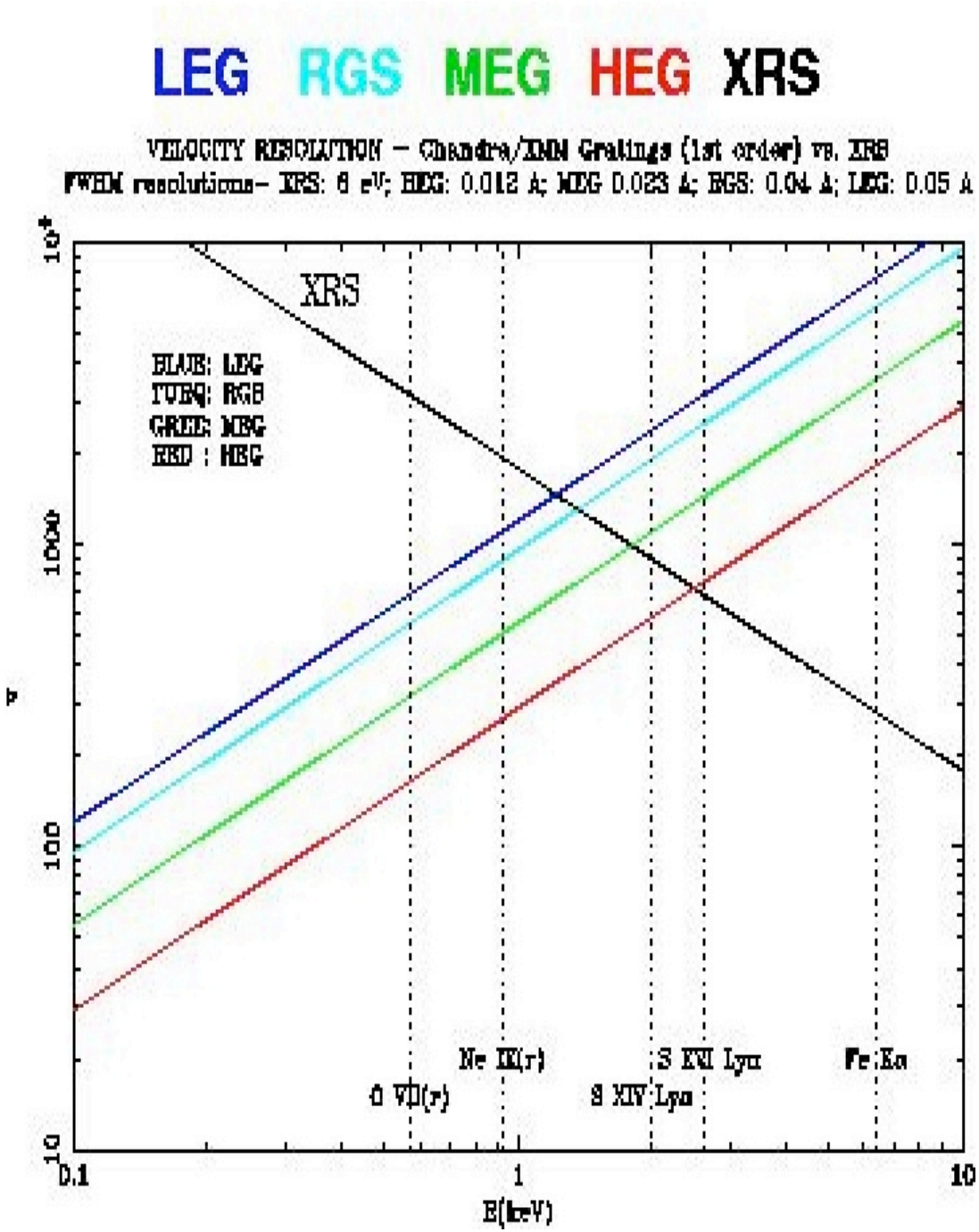


Flow along BH axis?



BAL model (left) driven by radiation-pressure. Large, high-ionisation, outflows harder to drive. Need bound-free and/or Compton scattering.

Alternative is magnetic field driving. Significant energy in magnetic field in PDS456.



Highest spatial resolution is needed to resolve iron K band components:- relativistic line, narrow line, ionised components and absorption lines and edges.

Calorimeter resolution needed (with Δv=100-300 km/s) at 6 keV - Astro-E2 XRS and Constellation-X

Conclusions - Observations of the iron K line

- **The broad relativistic (extremal Kerr?) appears robust in MCG -6-30-15.**
- **Generally, the simple redshifted broad line scenario (circa ASCA) appears too simplistic.**
- **Ionised iron K line components are observed in several AGN (Mrk 205, Mrk 509, NGC 5506, F9, NGC 7314). Origin in an ionised disc?**
- **"Narrow" iron K line appears almost ubiquitous in Seyfert 1s (but not QSOs). Origin is unclear (NLR, torus, BLR, outer disc) - needs higher resolution**
- **Highly ionised outflows detected in several (high accretion rate?) AGN, PG 1211+143, PDS 456 and Mrk 766. Also see Chartas talk.**